

January 5, 2005

TO: Eugene Burke

FROM: Napoleon Lacey

SUBJECT: Deep Space Station-27 Continuation in Service Report

## **SUMMARY**

DSS-27 is utilized to support the overflow of tracking support requirements from the 26M and the 34BWG1 Subnets. This study indicates that without DSS-27 the 26M Subnet percentage increase in unsupportable time for 2005 through 2008 is projected to range from 29% to 100%. The 34BWG1 Subnet percentage increase in unsupportable time for 2005 through 2008 is projected to range from 9% to 57%. The inclusion of the revised extended mission date requirements for Cluster 2, Polar, SOHO, Ulysses, and Wind plus the new Lunar-A launch requirements will increase the unsupportable percentage.

## **INTRODUCTION**

This study provides supporting data for DSS-27 to continue in service at least through the end of calendar year 2008. DSS-27, a 34 meter High Speed Beam-Waveguide (34HSB) antenna provides tracking support for S-band Low Earth Orbiter (LEO), High Earth Orbiter (HEO), and some additional S-band missions. The Resource Allocation Planning and Scheduling Office (RAPSO) performed a loading assessment, on April 21, 2003, within the scope of the RAPSO operational database to determine the impact on ongoing user tracking support requirements if DSS-27 is removed from service. This study, performed by RAPSO on December 15, 2004, will provide an updated loading assessment for 2005 through 2008.

## **BACKGROUND**

The tracking support capabilities of DSS-27 are limited to S-band LEO, HEO, and Sun-Earth Libration point orbit missions. The available capabilities allow this antenna to support a number of S-band missions that contribute to the forecast of high unsupportable tracking hours on the 26-meter (26M) and 34-meter beam waveguide 1 (34BWG1) Subnets. DSS-27 is utilized to support the tracking requests of missions such as Advance Composition Explorer (ACE), Chandra, and the SSMO missions, Cluster 2 (4 separate spacecrafts), Geotail, Polar, and SOHO. Most of these missions require S-band uplink and downlink and have viewperiod overlap from 25 to 100 percent. DSS-27 is also used to provide tracking support to these users when the 26M Subnet is providing launch and initial acquisition support. DSS-27 cannot support INTEGRAL because the station does not support the Space Link Extension (SLE) protocol because it is not fully equipped with uplink Network Simplification Project (NSP) equipment.

Deep Space Network antenna downtime is planned for several engineering, hardware, and software upgrades affecting all DSN complexes during the 2005 through 2008 time period (See Table 7). Scheduled and proposed downtimes adversely affect the loading on the entire network. Presently, we know there will be some downtime on the 26M Subnet, but the actual plan has not been approved.

During the DSN oversubscription for the Mars Asset Contention Period (ACP), a period of mission critical activities and events planned for late 2003 through the first quarter of 2004, DSS-27 played a major role in providing tracking support to the LEO, HEO, and various S-band missions during this time period.

### **ASSUMPTIONS:**

Assumptions used in preparation of this plan are as follows:

The decisions made at the Resource Allocation Review Board meetings regarding the reduction of support for 2005 through 2007 have been factored into this report.

For new missions, the first day of the launch window is used as the nominal launch date.

Each antenna aperture is capable of providing 168 hours of support per week, except for routine maintenance and downtime.

Ongoing and Advanced Mission Planning Sets as indicated in Table 5. Recent changes are colored “red”.

DSN Major Mission Events as indicated in Table 6 and 7.

DSN Major Downtimes as indicated in Table 8.

The following User Loading Profile (ULP) changes were not factored in this study due to the recent receipt of updated ULPs. The inclusion of the following additional tracking hours will increase the requested and unsupportable hours shown in the tables.

- Cluster 2 Four (4) spacecrafts with an end of extended mission date changed from 02/28/06 to 09/30/09
- Lunar-A Launch date changed from 08/14/04 to 08/01/07
- Polar End of extended mission date changed from 09/30/05 to 09/30/06
- Ulysses End of extended mission date changed from 12/31/06 to 03/30/08
- Wind End of extended mission date changed from 09/30/05 to 09/30/06

## **OBJECTIVES OF THE STUDY**

1. To perform an assessment of user loading on the DSN 34HSB, 34B1, and 26M Subnets to determine any impact on meeting ongoing mission tracking requirements in 2005 through 2008 if DSS-27 is removed from service.
2. To determine the utility in keeping DSS-27 in-service from 2005 through 2008.
3. To identify significant and critical events and planned major antenna downtimes that will affect the network loading in the 2005 through 2008 time period.

## **DSN ANTENNA RESOURCE ASSESSMENT AND IMPACT ANALYSIS**

The 34BWG1 and 26M Subnets have similar capabilities as the 34HSB, in that they have S-band uplink and S-band downlink capability. The 34BWG2 Subnet does not. Therefore, some S-band missions requesting tracking support on the 26M or 34BWG1 antennas are moved as needed to the 34HSB. The annual network load and utilization percentages on the 34BWG1 and 26M Subnets for 2005 through 2008 show that these Subnets are fully subscribed, and that DSS-27 provides the needed additional capacity to support NASA's LEO and HEO missions.

Table 1 shows the annual requested hours per Subnet for 2005 through 2008. Table 2 shows the annual unsupportable hours by Subnet due to oversubscription, and Table 3 provides the percent utilization of these Subnets. The inclusion of the above referenced additional hours will increase the requested hours and unsupportable hours by Subnet shown in the following tables due to changes in end of extended mission dates (EOEM).

**Table 1: Annual Requested Time by Subnet in Hours**

<b>YEAR</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>34BWG1</b>	16,014	15,860	17,733	18,111
<b>34HSB</b>	2,093	2,268	1,287	1,199
<b>26M</b>	15,973	13,049	12,122	12,222

**Table 2: Annual Unsupportable Time by Subnet in Hours**

<b>YEAR</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>34BWG1</b>	1,192	1,096	1,423	2,778
<b>34HSB</b>	141	189	207	72
<b>26M</b>	1,559	1,045	1,169	1,239

**Table 3: Annual Utilization Percentage**

<b>YEAR</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>34BWG1</b>	65%	63%	71%	69%
<b>34HSB</b>	25%	26%	15%	14%
<b>26M</b>	61%	50%	46%	47%

The following are prime users routine support and major events that will be impacted if DSS-27 is deactivated:

Chandra will experience unsupportable time due to critical Mars support, mission events, and other user's events that over subscribes the 34BWG1 and 26M Subnets.

Cluster 2 four (4) spacecrafts requires DSS-27 to support the 4-station array for Wide Band Data gathering. DSS-14 and DSS-15 are not readily available due to the number of Mars missions requesting 70M and 34HEF support.

Polar depends on DSS-27 to provide TCM support and to fulfill the gaps in their day to day real-time coverage plus data playback routine support that cannot be met on the 34BWG1 and 26M Subnet due to their over subscription.

SOHO Helioseismology Observation (HSO), an experiment that occurs once a year, requires 60-days of continuous support plus additional 30-days of continuous support on a best efforts basis. DSS-27 provides one third of the support hours for this experiment. The HSO experiments depend a great deal on tracking support provided by DSS-27.

SOHO Temporal Solar Observation (TSO), an experiment that occurs every four weeks (minus HSO and Antenna Keyhole events) and requires continuous coverage for five-days. DSS-27 provides one third of the support hours for this experiment.

**Table 4: Unsustainable Hours of Requested Hour and Delta Percentage**

<b>26M Annual Unsustainable Hours</b>			
<b>Year</b>	<b>With DSS-27 In Service</b>	<b>Without DSS-27 In Service</b>	<b>Increase in Lost Time %</b>
<b>2005</b>	1559	2138	37%
<b>2006</b>	1045	2101	101%
<b>2007</b>	1169	1507	29%
<b>2008</b>	1239	1940	57%

<b>34BWG1 Annual Unsustainable Hours</b>			
<b>Year</b>	<b>With DSS-27 In Service</b>	<b>Without DSS-27 In Service</b>	<b>Increase in Lost Time %</b>
<b>2005</b>	1192	1878	57%
<b>2006</b>	1096	1817	66%
<b>2007</b>	1423	1925	35%
<b>2008</b>	2778	3021	9%

## **CONCLUSIONS AND RECOMMENDATIONS**

The primary focus of this study is to determine the impact of removing DSS-27 from service on user loading. The present Projects/User loading on the 26M and the 34BWG1 Subnets show these Subnets to be fully subscribed from 2005 through September 2008. DSS-27 is utilized to support the overflow of tracking support requirements from the 26M and the 34BWG1 Subnets. This study indicates that without DSS-27 the 26M Subnet percentage increase in unsupportable time for 2005 through 2008 is projected to be 37%, 101%, 29%, and 57%, respectively. The 34BWG1 Subnet percentage increase in unsupportable time for 2005 through 2008 is projected to be 57%, 66%, 35%, and 9%, respectively, without DSS-27.

This study found that DSS-27 is a very useful and important antenna in providing needed additional support to a number of missions that would lose valuable day-to-day support. The 34 HSB, the 26M Subnet, and the 34BWG1 Subnet are the only antennas remaining under the DSN umbrella that have S-band uplink and downlink capability to support the ongoing S-band mission set in LEO and HEO. DSS-27 is especially useful for missions competing with SOHO during their annual HSO and monthly TSO experiments. Cluster 2, Geotail, and Polar will experience increased unsupportable time if DSS-27 is not used.

The forecast planning for the first half of 2005 have been completed. The Mid-Range Planning Team has negotiated the schedules through May of 2005. To remove DSS-27 from service prior to 2008 would result in a major increase in time and effort to negotiate conflict free schedules for the first half of 2005. The inclusion of the end of extended mission dates for Cluster 2, Polar, SOHO, Ulysses, and Wind plus the new Lunar-A launch requirements will increase the unsupportable hours.

ACE Mission Director reported during the Science Meeting at Caltech on October 11, 2004 that DSS-27 has better telemetry acquisition performance than the 26M Subnet at low Sun-Earth Vehicle (SEV) Angeles. See Chart 9.

DSS-27 is useful for supporting the Goldstone S-Band missions during the weekly routine maintenance and phasing periods for DSS-16 (Tuesday - 12 hours) and routine maintenance for DSS-24 (Wednesday - 8 hours). DSS-27 maintenance is always scheduled on Friday when both DSS-16 and DSS-24 are operating.

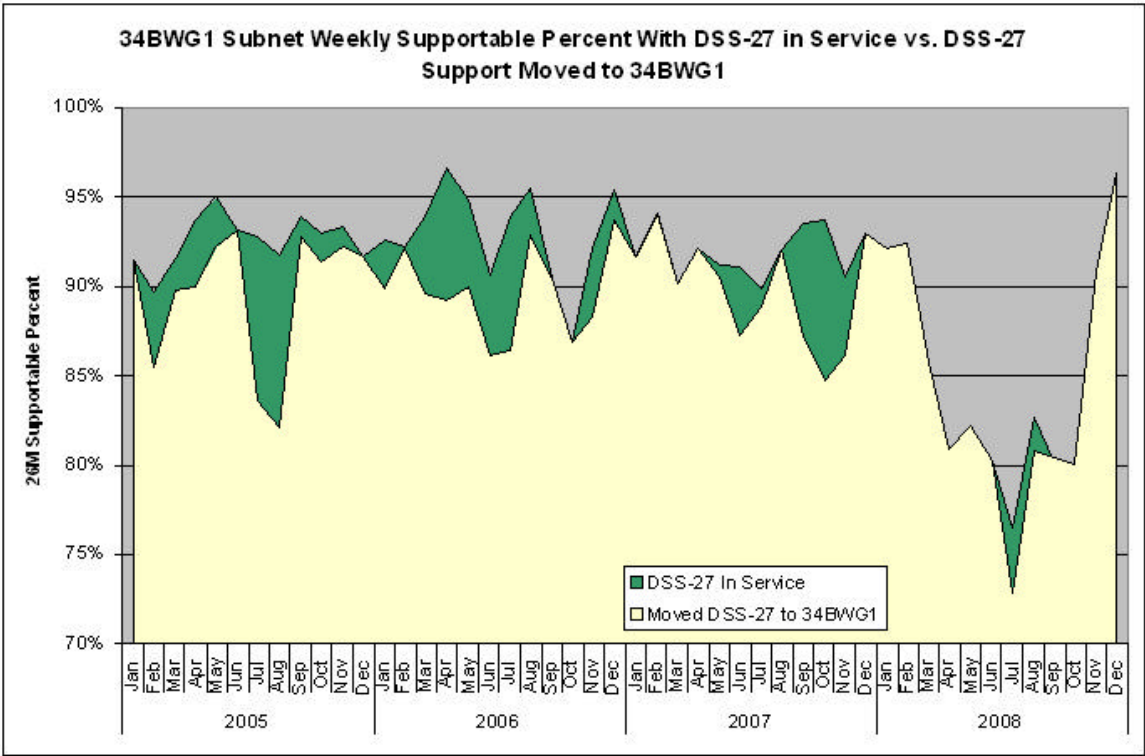
DSS-27 will be extremely valuable during the DSS-34 (X/X Ka Band) downtime in mid-February through early April, 2005; during the DSS-24 (USC Installation) downtime in mid-June, 2005; for the DSS-54 (USC Installation) downtime in mid-July, 2005; during the DSS-24 (X/X Ka Band) downtime in early September to late October, 2006; and the DSS-54 (X/A Ka Band) downtime in early June to late July, 2007.

It is also recommended that DSS-27 be equipped with the NSP capability (uplink) to enable the station to support the INTEGRAL mission.

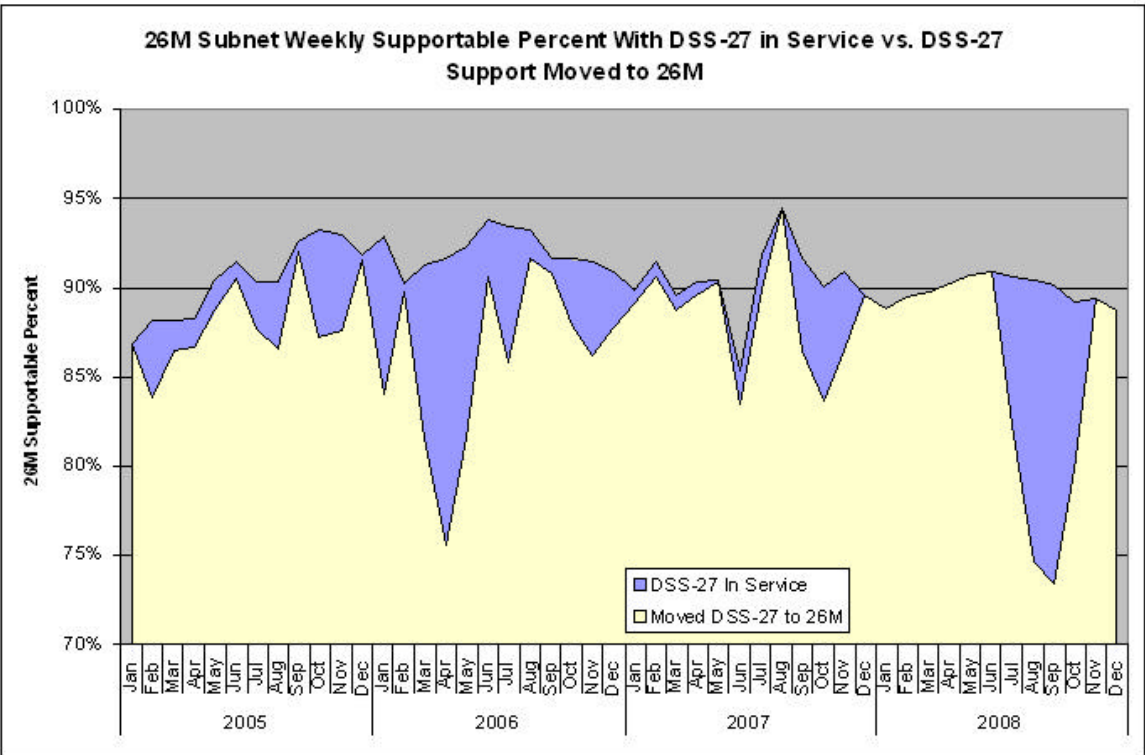
Project/Users regard DSS-27 as the antenna that is available to provide needed support when there is no other antenna available. Although, the user load on the charts may reflect a low percentage of unsupportable time, the extension to the end of extended mission for the SSMO missions will be greatly impact the DSN unsupportable time if DSS-27 is decommissioned. Therefore, this analysis strongly recommends that DSS-27 antenna remain in service through the end of calendar year 2008.

**SUPPORTING DATA:**

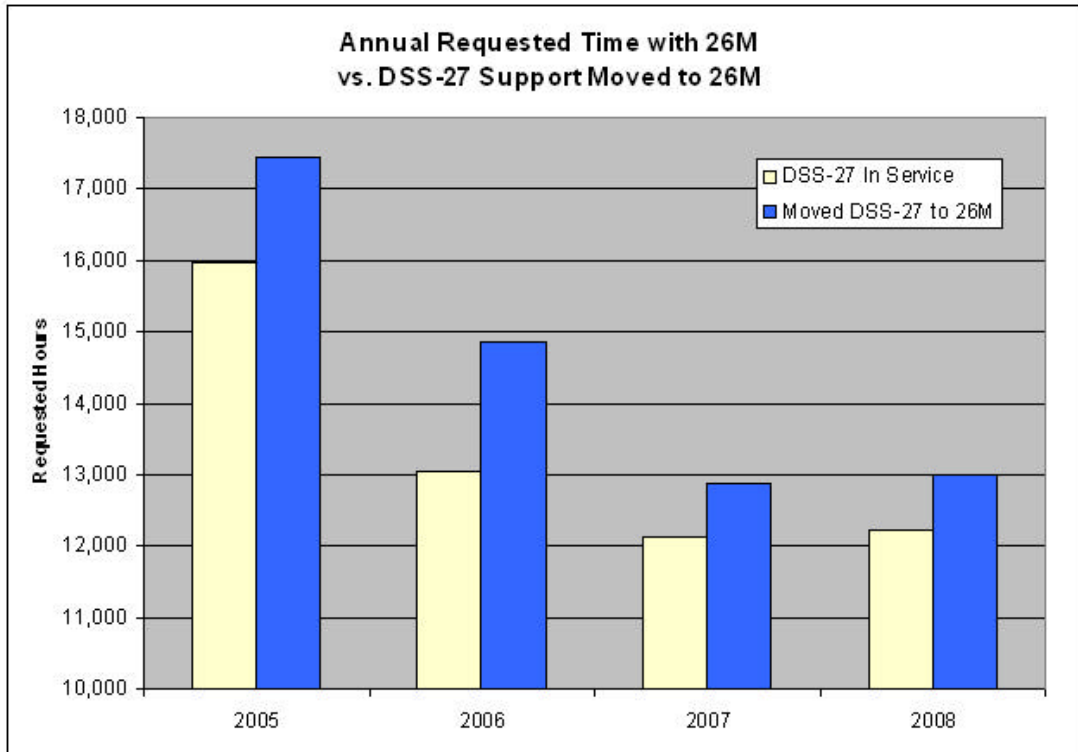
**Chart 1: 34BWG1 Monthly Percentage of Supportable Time**



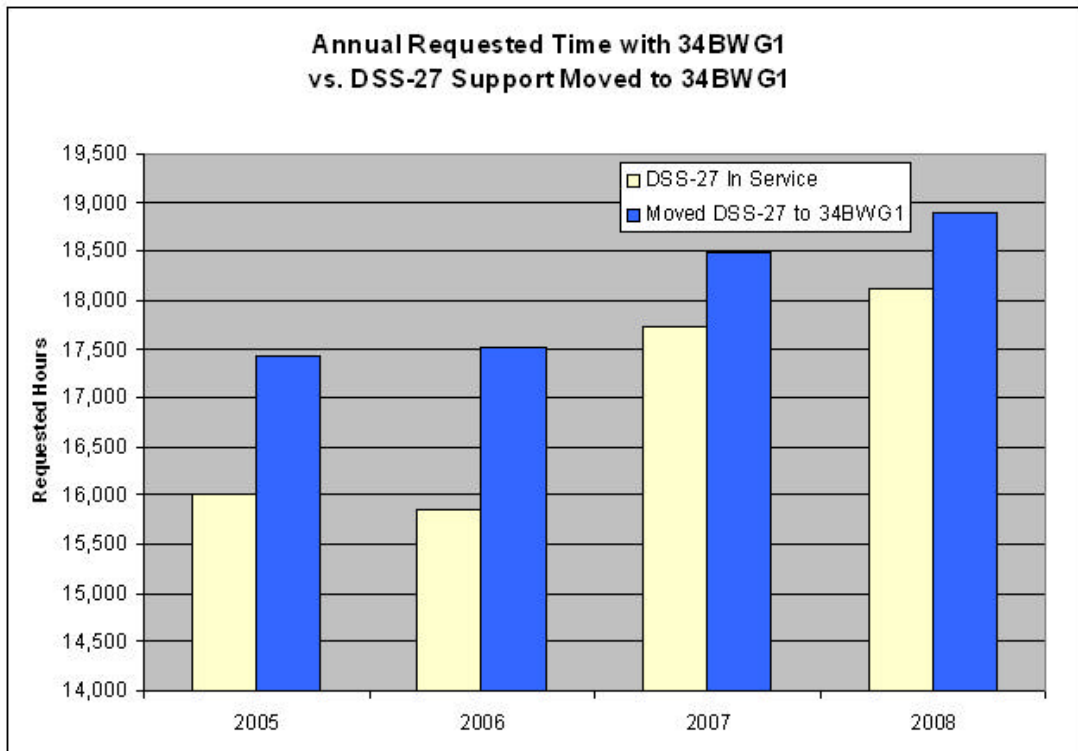
**Chart 2: 26M Monthly Percentage of Supportable Time**



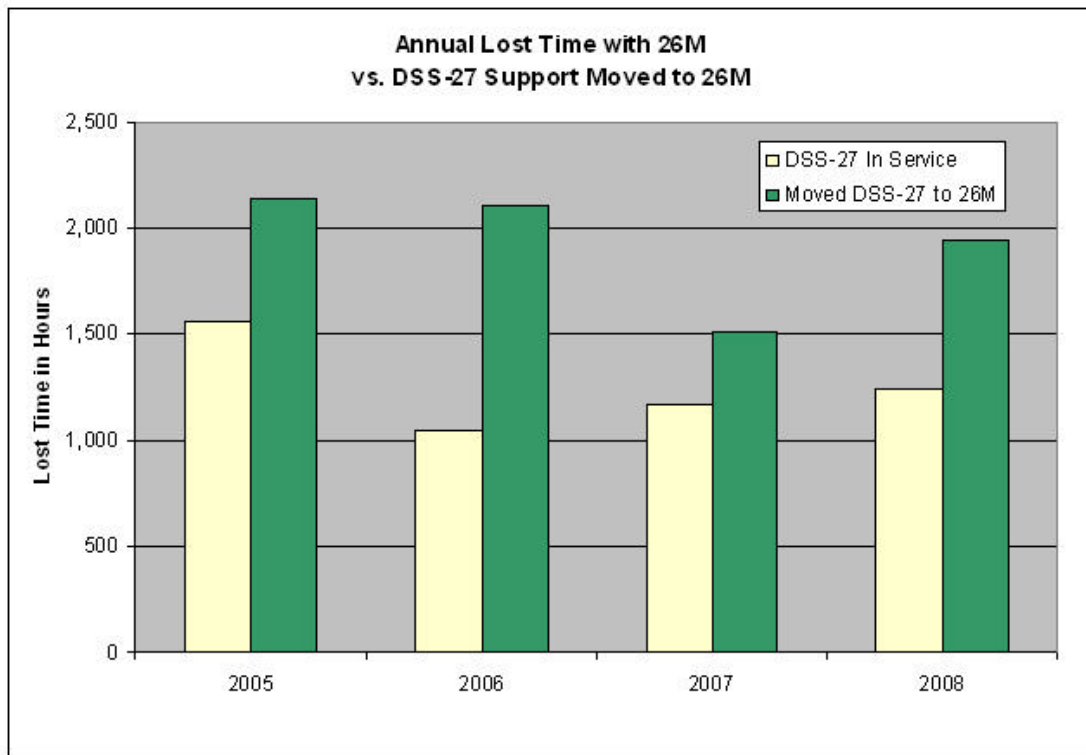
**Chart 3: 2005 – 2008 26M Subnet Requested Time**



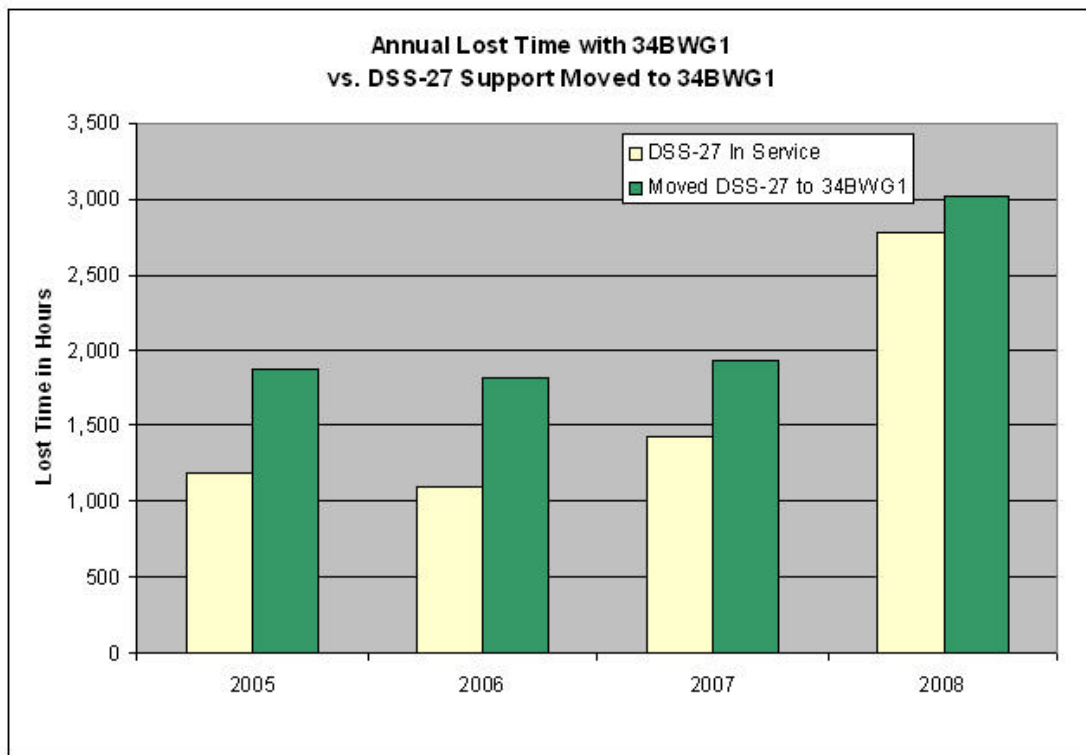
**Chart 4: 2005 – 2008 34 BWG1 Subnet Requested Time**



**Chart 5: 2005 – 2008 26M Subnet Lost Time**

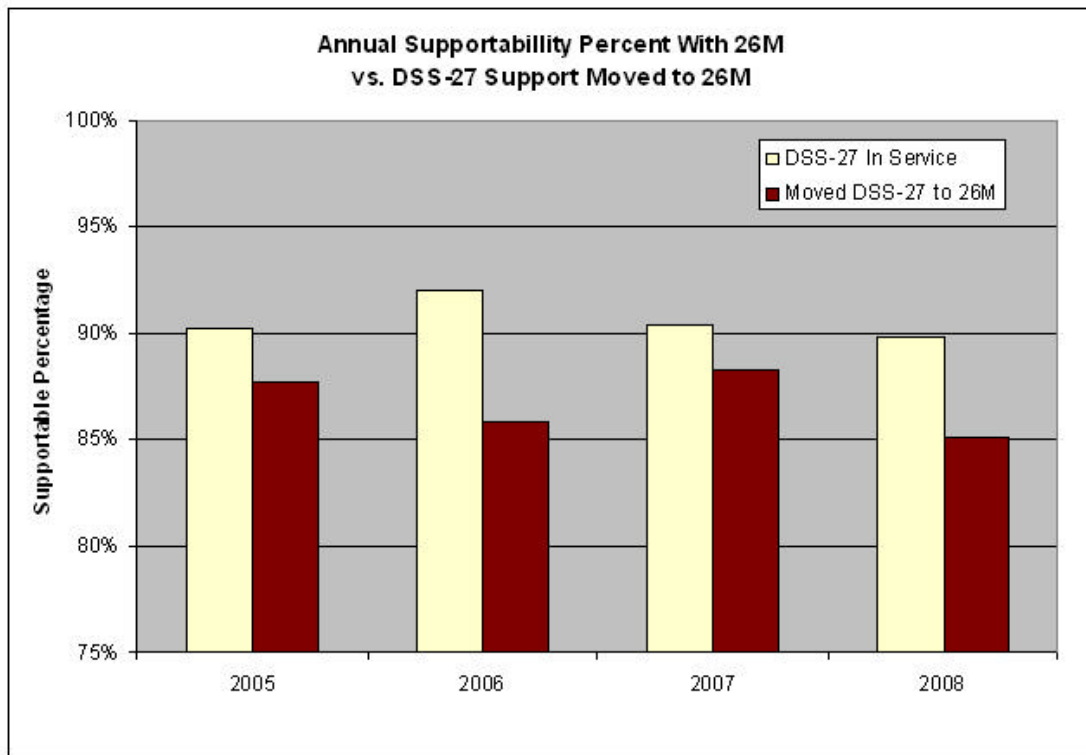


**Chart 6: 2005 – 2008 34B1 Subnet Lost Time**





**Chart 7: 2005 – 2008 26M Subnet Supportable Percent**



**Chart 8: 2005 – 2008 34BWG1 Subnet Supportable Percent**

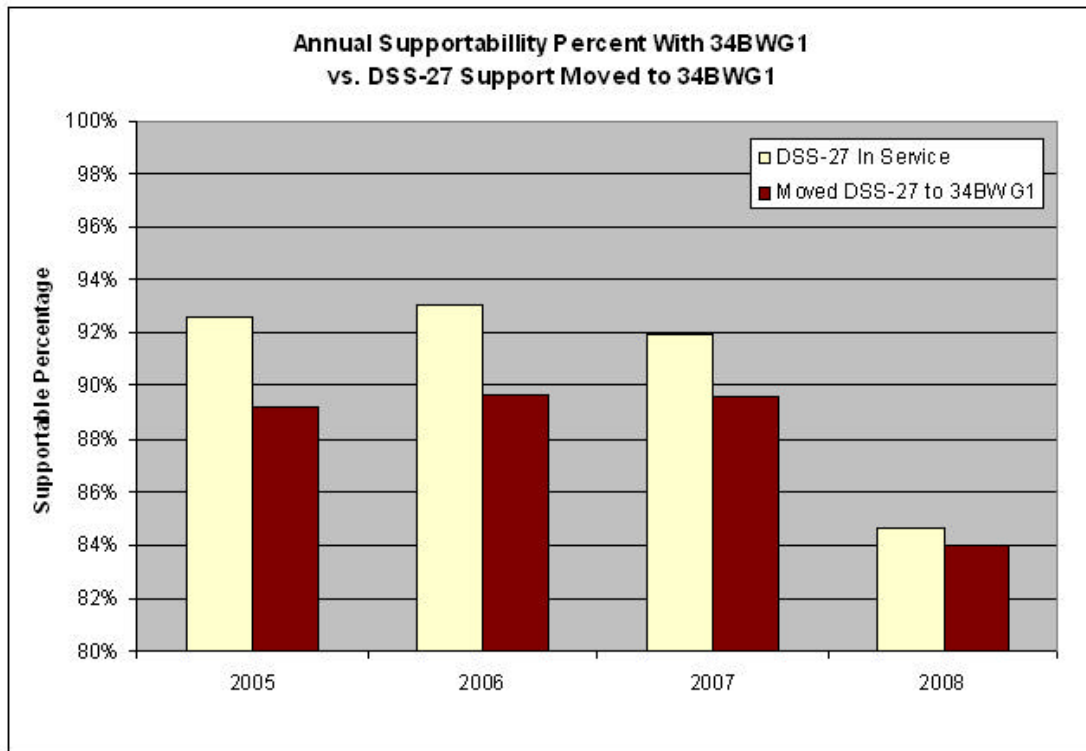
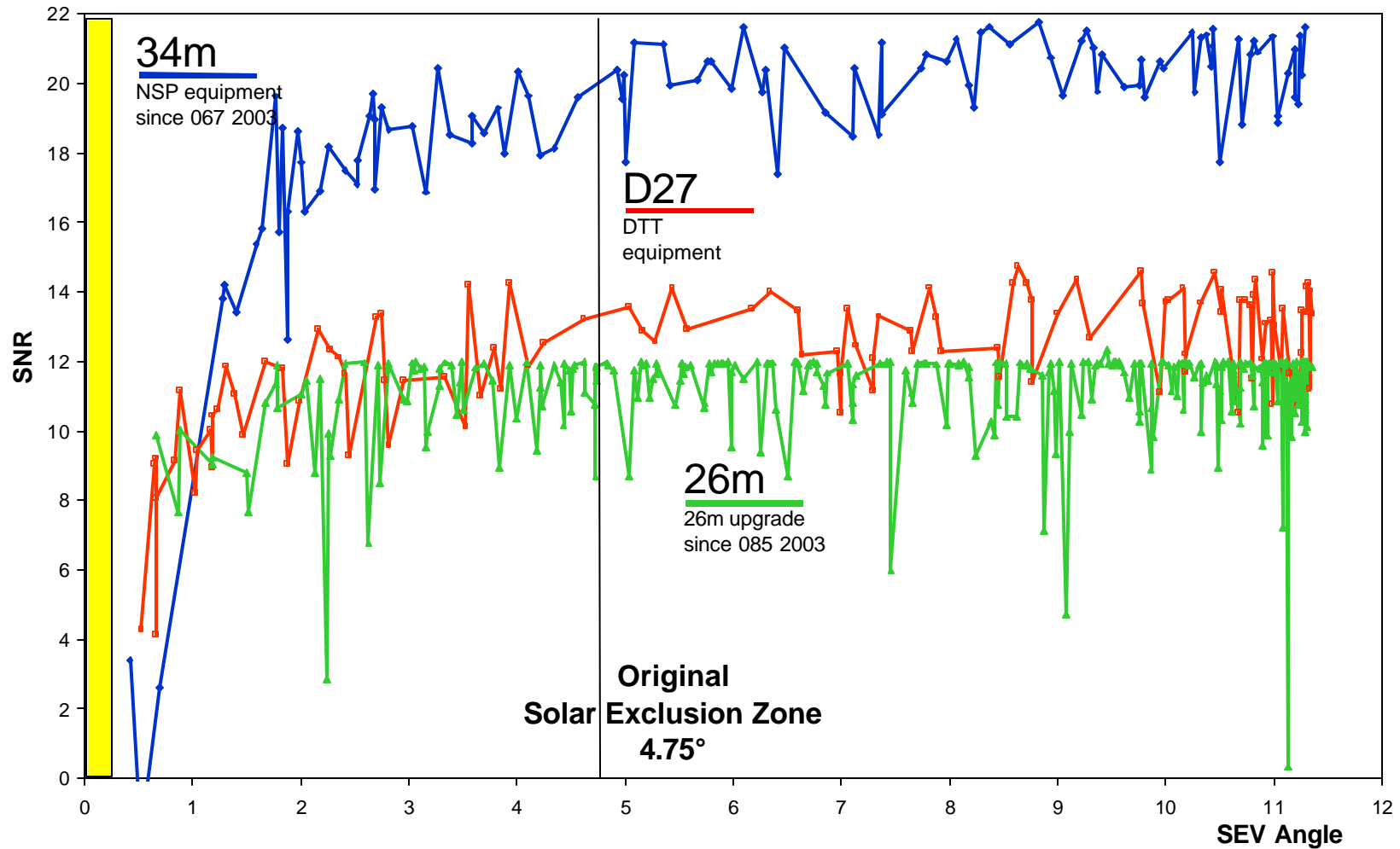


Chart 9:

**DSN Antenna Performance  
Signal to Noise vs SEV Angle**

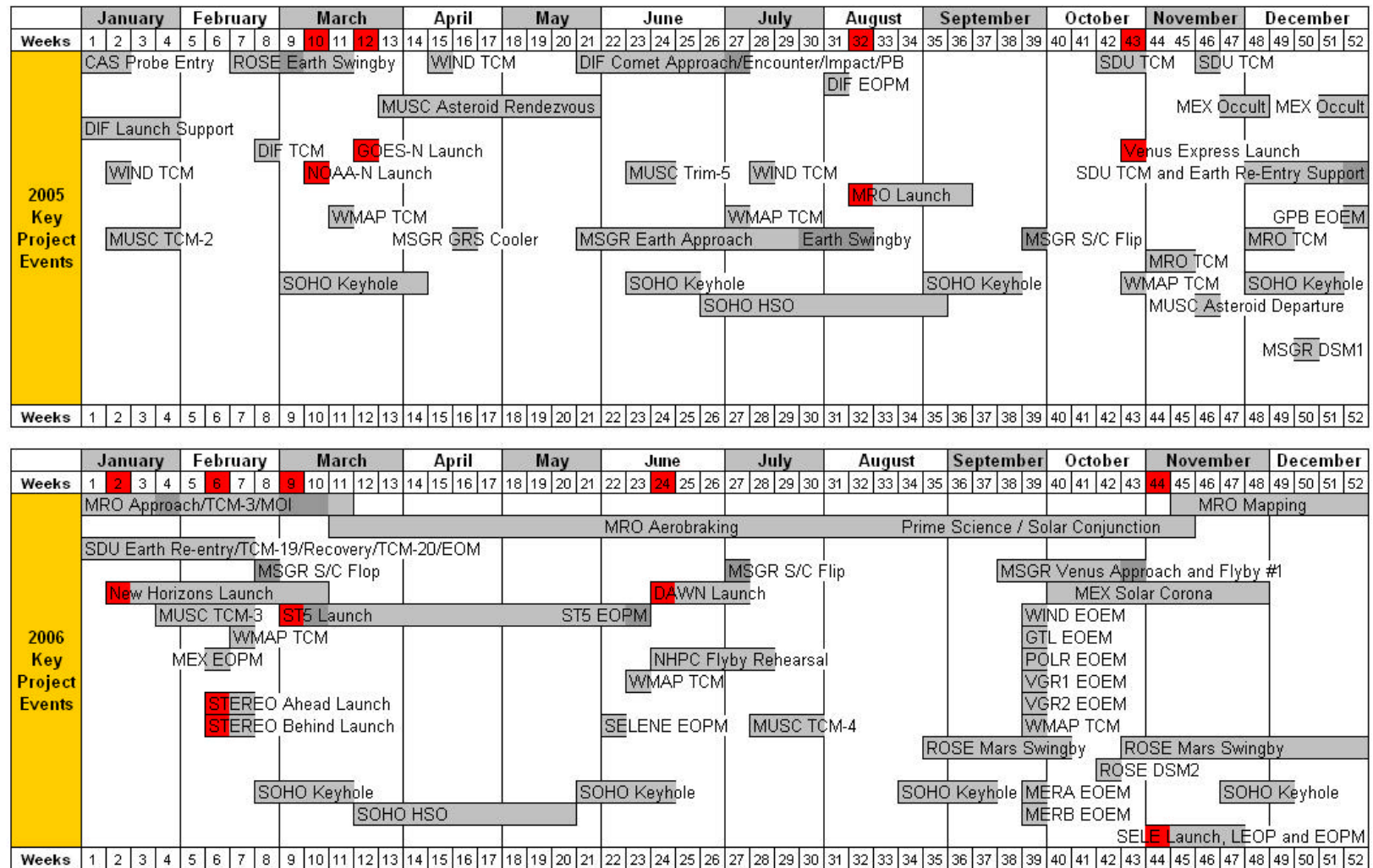


## ADDITIONAL TABLES:

Table 5: Ongoing, Advanced Users Mission Planning Set

ONGOING/PLANNED PROJECTS					ONGOING/PLANNED PROJECTS (Continue@)				
Project	Acronym	Launch or Start	EOPM	EOEM	Project	Acronym	Launch or Start	EOPM	EOEM
DSN Antenna Calibration	DSN	--	--	--	Hayabusa (MUSES - C)	MUSC	05/09/03	06/10/07	---
DSS Maintenance	DSS	--	--	--	Mars Express Orbiter	MEX	06/02/03	02/11/06	12/31/08
DSN ZDD Calibration	DSN	11/01/04	--	--	Spirit (Mars Exploration Rover - A)	MER2	06/10/03	04/06/04	09/30/06
European and Global VLBI Systems (EGS)	EVN	--	--	--	Opportunity (Mars Exploration Rover - B)	MER1	07/07/03	04/27/04	09/30/06
Ground Based Radio Astronomy	GBRA	--	--	--	Spitzer Space Telescope (SIRTF)	STF	08/25/03	02/25/06	10/19/08
Reference Frame Calibration (Cat M&E and Clock Sync)	DSN	--	--	--	Rosetta	ROSE	02/26/04	12/31/15	---
Space Geodesy	SGP	--	--	--	Messenger	MSGR	08/03/04	03/19/12	---
Voyager 2	VGR2	08/20/77	10/15/89	09/30/06	Deep Impact	DIF	12/30/04	08/05/05	---
Voyager 1	VGR1	09/05/77	12/31/80	09/30/06	Mars Reconnaissance Orbiter	MRO	08/10/05	12/31/10	12/31/15
Goldstone Solar System Radar	GSSR	04/01/85	--	--	New Horizons	NHPC	01/11/06	04/17/16	TBD
Ulysses	ULYS	10/06/90	09/11/95	03/30/08	Lunar - A	LUNA	06/01/07	02/04/08	---
Geotail	GTL	07/24/92	07/24/95	09/30/06	Stereo Ahead	STA	02/11/06	05/16/08	05/17/11
Wind	WIND	11/01/94	11/01/97	09/30/06	Stereo Behind	STB	02/11/06	05/16/08	05/17/11
SOHO	SOHO	12/02/95	05/02/98	12/31/08	Space Technology 5	ST5	03/01/06	05/30/06	TBD
Polar	POLR	02/22/96	08/23/97	09/30/06	Dawn	DAWN	06/17/06	01/12/16	TBD
Gravity Probe B (non Spacecraft support)	GPB	06/01/96	05/30/05	12/31/05	ADVANCED PLANNING PROJECTS				
Mars Global Surveyor	MGS	11/07/96	02/01/01	11/03/08	Project	Acronym	Launch or Start	EOPM	EOEM
Advance Composition Explorer	ACE	08/25/97	02/01/01	09/30/10	Venus Express *	VEX	10/26/05	04/09/06	TBD
Cassini	CAS	10/15/97	06/30/06	06/30/10	SELENE *	SELE	11/01/06	11/21/06	TBD
Stardust	SDU	02/07/99	02/15/06	---	Kepler	KEPL	10/01/07	07/01/11	TBD
Chandra X-ray Observatory	CHDR	07/23/99	07/24/09	07/24/14	Phoenix	PHX	08/03/07	10/26/08	TBD
Imager for Magnetopause-to-Aurora Global Exploration	IMAG	03/25/00	05/30/02	09/30/10	Mars Telecommunications Orbiter 2009	MTO	09/22/09	08/19/20	TBD
Cluster 2 - S/C #2 (Samba)	CLU2	07/16/00	02/15/03	09/30/09	Mars Science Laboratory 2009	MSL	10/25/09	03/04/12	TBD
Cluster 2 - S/C #3 (Rumba)	CLU3	07/16/00	02/15/03	09/30/09	Space Interferometry Mission	SIM	02/14/10	08/30/20	TBD
Cluster 2 - S/C #1 (Salsa)	CLU1	08/09/00	02/15/03	09/30/09	James Webb Space Telescope	JWST	08/01/11	07/31/16	TBD
Cluster 2 - S/C #4 (Tango)	CLU4	08/09/00	02/15/03	09/30/09	Mars Placeholder 2011	M11L	10/30/11	09/10/14	TBD
Mars Odyssey 2001	MO10	04/07/01	08/24/04	11/30/08	Mars Placeholder 2013	M13O	11/26/13	08/21/16	TBD
Wilkinson Microwave Anisotropy Probe	WMAP	06/30/01	10/01/03	09/30/08	* DSN support may not be required for these missions				
Genesis	GNS	08/08/01	09/08/04	12/30/04					
Advanced Tracking and Observational Techniques (ATOT)	ATOT	02/01/02	12/31/08	---					
International Gamma Ray Astrophysics Lab	INTG	10/17/02	12/18/04	12/31/08					

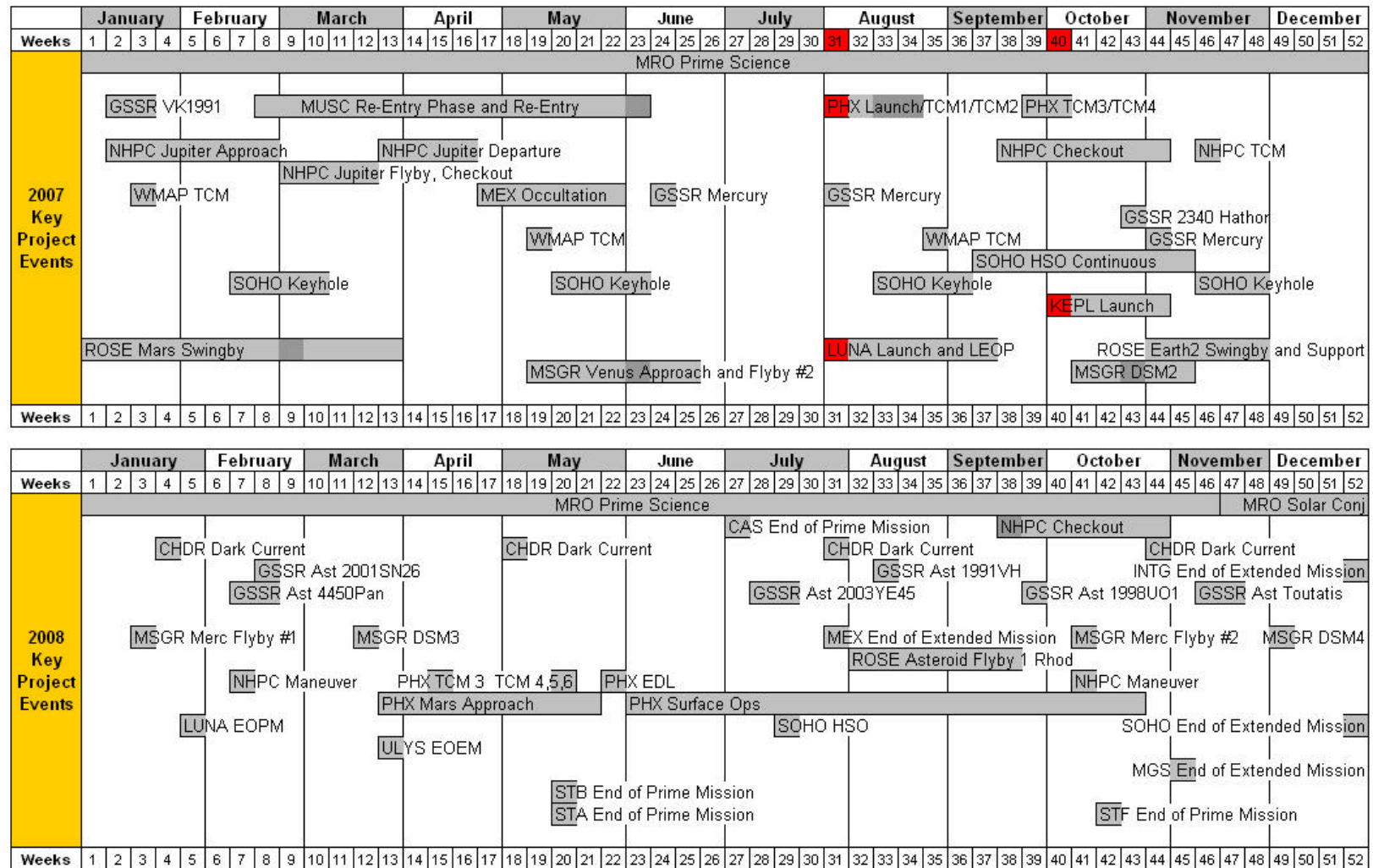
**Table 6: DSN Major Mission Events 2005 - 2006**



Revised: November 19, 2004

Red box = Week of Launch    Grey box = Event Phase    Black box = Major Event within Phase

**Table 7: DSN Major Mission Events 2007 - 2008**



Revised: November 19, 2004

= Week of Launch
  = Event Phase
  = Major Event within Phase



**Table 8: DSN Major Downtime Schedule 2007 - 2008**

## DSN Antenna Downtime Report

Revised: November 1, 2004

2005							
Site	Description	Start	End	Duration (Days)	Weeks	Start DOY	End DOY
DSS 27	USC Installation	01/10/2005 00:00	01/23/2005 23:59	14	02 - 03	010	023
DSS 63	USC Installation	01/17/2005 00:00	01/30/2005 23:59	14	03 - 04	017	030
DSS 26	USC Installation	01/24/2005 00:00	02/06/2005 23:59	14	04 - 05	024	037
DSS 65	Antenna Controller Replacement	01/31/2005 00:00	07/03/2005 23:59	154	05 - 26	031	184
DSS 65	NIB - USC Installation	01/31/2005 00:00	02/06/2005 23:59	7	05 - 05	031	037
DSS 65	Relocation	01/31/2005 00:00	07/03/2005 23:59	154	05 - 26	031	184
DSS 65	Life Extension	01/31/2005 00:00	07/03/2005 23:59	154	05 - 26	031	184
DSS 34	X/X-Ka Band	02/15/2005 00:00	04/10/2005 23:59	55	07 - 14	046	100
DSS 34	NIB - USC Installation	02/15/2005 00:00	03/06/2005 23:59	20	07 - 09	046	065
DSS 34	NIB - Azimuth Idler Bearing	02/15/2005 00:00	04/10/2005 23:59	55	07 - 14	046	100
DSS 15	USC Installation	04/25/2005 00:00	05/08/2005 23:59	14	17 - 18	115	128
DSS 25	USC Installation	05/30/2005 00:00	06/12/2005 23:59	14	22 - 23	150	163
DSS 24	USC Installation	06/27/2005 00:00	07/03/2005 23:59	7	26 - 26	178	184
DSS 55	USC Installation	07/04/2005 00:00	07/10/2005 23:59	7	27 - 27	185	191
DSS 54	USC Installation	07/11/2005 00:00	07/16/2005 23:59	6	28 - 28	192	197
DSS 43	Antenna Controller Replacement	07/18/2005 00:00	01/01/2006 23:59	168	29 - 52	199	001
DSS 43	NIB - USC Installation	07/18/2005 00:00	07/31/2005 23:59	14	29 - 30	199	212
DSS 43	Hydrostatic Bearing	07/18/2005 00:00	01/01/2006 23:59	168	29 - 52	199	001
DSS 15	Antenna Controller Replacement	09/12/2005 00:00	11/20/2005 23:59	69	37 - 46	255	323

2006							
Site	Description	Start	End	Duration (Days)	Weeks	Start DOY	End DOY
DSS 63	Antenna Controller Replacement	05/22/2006 00:00	09/03/2006 23:59	105	21 - 35	142	246
DSS 24	X/X-Ka Band	09/04/2006 00:00	10/22/2006 23:59	49	36 - 42	247	295
DSS 45	Antenna Controller Replacement	10/09/2006 00:00	12/10/2006 23:59	63	41 - 49	282	344

2007							
Site	Description	Start	End	Duration (Days)	Weeks	Start DOY	End DOY
DSS 54	X/X-Ka Band	06/04/2007 00:00	07/29/2007 23:59	56	23 - 30	155	210

<http://rapweb.jpl.nasa.gov>

Although every effort is made to ensure the accuracy of this Downtime Planning report, changes can and do occur.

The DSN 7-Day Schedule takes precedence over this document.